

ACUTE APPENDICITIS: AN ANALYSIS OF 500 CASES.

BY FENWICK BEEKMAN, M.D., MORRIS K. SMITH, M.D.,

AND

SUMNER EVERINGHAM, M.D.

NEW YORK.

(From the Cornell University Surgical Division, Bellevue Hospital.)

THE cases forming the basis of this study were admitted to the surgical services of the first, second, and third divisions of Bellevue Hospital from the years 1911 to 1916 inclusive, and represents the work of many different surgeons.

These cases were carefully collected, including only those in which the evidence of acute inflammation of the appendix was satisfactory. We thus found it necessary to reject about one-third of the cases filed as acute appendicitis, as the data was not sufficiently conclusive to class them as such. Pathological examination was not recorded in many of the cases, but a definite judgment could be formed upon the clinical picture and the gross appearance of the appendix and surrounding tissues.

It was our experience that if the gross appearance of the appendix was not evidently that of acute disease, there was seldom other sufficient evidence to so regard it. We did not find in these records satisfactory evidence of such an entity as the often-named acute catarrhal appendicitis, and have rejected, to the disparagement of our mortality figures, many of the cases which would have gone into this class. To substantiate these views we quote from Moschcowitz:

"To recognize that an appendix is diseased or normal, the microscope . . . is by no means always necessary. I believe that in 90 per cent. the diagnosis of a present or previous appendicitis may be easily recognized by the naked eye.

"I emphasize the appearance of a localized appendicular peritonitis because it is not generally appreciated that a local peritonitis is already present in the early stages of the disease. I have never seen an appendix acutely inflamed that did not show this lesion, although I confess that I do not recall ever having examined an appendix removed in the first twelve hours after the onset of the symptoms. Without any further evidence, therefore, the absence, even grossly, of a localized appendicular peritonitis practically excludes an acute appendicitis . . . The lesion of acute appendicitis is not a catarrhal inflammation as understood in the pathological sense. Indeed, acute and even chronic inflammations of the appendix do not occur."

Stanton says: "Catarrhal appendicitis is not found as a primary

condition," and quotes from Kocher as saying: "I see appendicitis catarrhalis only as a chronic form and as a residue after acute attacks."

We propose first to discuss the mortality and complications and then such diagnostic and prognostic features of interest as may be gathered from the data collected.

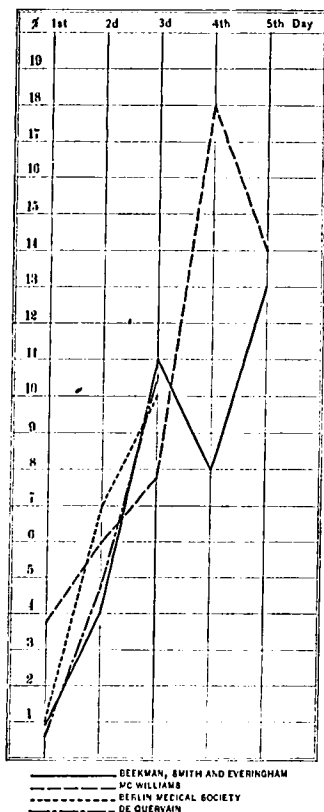
MORTALITY. There were 34 deaths, or a mortality of 6.8 per cent. The accompanying table is a compilation of some report selected from the literature of acute appendicitis. In considering them it must be remembered that those that run back ten to fifteen years, as that from Mt. Sinai Hospital, antedate in part the employment of the Murphy drip and Fowler position, the introduction of which have considerably reduced the mortality in severe cases.

	No. of cases.	Died.	Mortality (per cent.).
Bellevue Hospital, 1911-1916	500	34	6.8
Roosevelt Hospital, 1910-1915 (Stillman)	965	46	4.7
Presbyterian Hospital, 1906-1909 (McWilliams)	687	68	9.8
Mt. Sinai Hospital, 1899-1906 (Moschowitz)	1,503	202	13.4
Schnitzler	937	98	10.5
Kummell (German Surgical Congress, 1910)	574	11	2.0
Zander	308	30	9.7
Zahradnický	611	35	5.4
Alt Berlin Hospitals, 1907 (from McWilliams)	1,344	197	14.6
Syms, 1900-1912	100	8	7.5
Burgess, 1906-1911	500	40	8.0
Denk, 1907-1911	467	29	6.2
Davis	260	15	5.75
Haggard	265	12	4.5
DeQuervain, 1908-1913	5,097	417	8.1
Total	14,154	1,242	8.7

These figures demonstrate the seriousness of acute appendicitis. The most impressive study in this connection is, however, the relation of time of operation to mortality. From a condition whose death rate is approximately that of typhoid fever the disease reduces itself to one with a mortality of only 1 per cent. if operation is done within the first twenty-four hours. By the end of the second day the mortality has quadrupled, although still considerably below the general average. By the end of the third day the mortality has passed far above the general average—almost as high a figure as is attained at any time. The lesson of this is that in the presence of virulent infections and low resistance a delay of seventy-two hours seriously compromises the hope of recovery. The operation done later than twenty-four hours after the onset of symptoms cannot be considered early. It is of interest to note that of the fatal cases in this series, twice as many died who were operated upon the third day after the onset of symptoms as on any other day of the illness. The accompanying table includes the cases in which the time of operation was known:

Day of illness operated upon.	Number of cases.	Deaths.	Mortality (per cent.).
First	111	1	0.9
Second	109	4	4.0
Third	89	10	11.0
Fourth	60	5	8.0
Fifth	39	5	13.0
Sixth and seventh	33	4	12.0
Second week	33	3	9.0
More than two weeks	13		

Figures from other clinics in general agree with ours. McWilliams' statistics from the Presbyterian Hospital, New York City are:



The rate of mortality in acute appendicitis in reference to the day of the attack on which the operation is performed.

Day of illness operated upon.	Mortality (per cent.).
First	3.7
Second	6.0
Third	7.7
Fourth	18.0
Fifth	14.0
Sixth	14.0
Seventh	20.8
Seventh to tenth	20.0
Tenth to fourteenth	15.3

A Commission of the Berlin Medical Society for Berlin Hospitals, 1907, report as follows:

Day of illness operated upon.	Mortality (per cent.).
First	0.9
Second	7.0
Third	10.0
Later	23.0

De Quervain's report from the Swiss Hospitals, 1908 to 1913, gives us the following, from 5097 cases:

Day of illness operated upon.	Mortality (per cent.).
First	0.69
Second	4.7
Third	10.7
Later	21.2

Another factor influencing mortality is the age of the patient; the very young and the elderly often succumb. In this series the mortality of those under ten years and over fifty is 23 per cent. as opposed to a mortality of 4.7 per cent. for those between. This increase in mortality in the young and old is confirmed by studying the following table, which gives the mortality of the young and old, depending upon the day of the attack on which operation was performed, compared with those of the whole series:

Day of illness operated upon.	Mortality of series, 590 cases (per cent.).	Mortality of young and aged (per cent.).
First	0.9	0.0
Second	4.0	31.0
Third	11.0	25.0
Fourth	8.0	33.0
Fifth	13.0	33.0

The causes of death in our series of cases were:

Diffuse peritonitis	18
Diffuse peritonitis with left iliac phlebitis and pleurisy	1
Diffuse peritonitis with multiple liver abscesses and pleurisy	1
Diffuse peritonitis with pneumonia	1
Prolonged sepsis and fecal fistula	3
Sepsis	1
Septicemia and pneumonia	1
Subphrenic abscesses	2
Pneumonia	3
Pulmonary embolism	1
Alcoholism	1
Facial erysipelas	1

COMPLICATIONS. These may be divided into two classes, complications already present at time of operation and postoperative sequelae. The complications already present at operation were:

Complication.	Incidence (per cent.).	Cases.	Mortality (per cent.).
Abscess	21.0	107	5.6
Diffuse peritonitis	9.0	45	47.0
Tuboovarian abscess	0.4	2	
Acute cholecystitis (suppurative)	0.4	2	50.0
Obstruction due to adhesions	0.2	1	
Salpingitis	0.2	1	
Toxemia of pregnancy	0.2	1	100.0
Alcoholism	0.2	1	100.0
Pulmonary tuberculosis	0.2	1	100.0
Nephritis	0.2	1	100.0

These complications were found in 151 individuals, or 30 per cent. The mortalities here quoted do not necessarily represent the mortality of a given complication, as more than one complication often existed in the same individual. For instance, in the cases dying in which pulmonary tuberculosis and nephritis were quoted as complications there was in addition diffuse peritonitis.

Abscess. There were 107 cases of appendicular abscess, or 21 per cent. of the total cases studied. The mortality was 5.7 per cent. (6 deaths), a little better than the general mortality. The causes of death were diffuse peritonitis 4, pneumonia 1, and erysipelas 1. The incidence of other complications was approximately that of the whole series. Fecal fistula occurred relatively more frequently, 8 times. This is perhaps due to the fact that in 18 of these cases or 17 per cent., the appendix was not removed. Abscess should occur in only a small percentage of cases promptly operated upon, less than 3 per cent. the first day as opposed to over 50 per cent. in those delaying beyond the fourth day. The following table demonstrates this fact:

Cases operated upon.	Days ill.	Abscesses found.	Incidence (per cent.).
111	1	3	2.7
109	2	10	15.0
89	3	11	12.0
60	4	12	20.0
39	5	18	46.0
33	6 and 7	17	51.0
33	2d week	20	60.0
13 more than 2 weeks		0	00.0

Diffuse Peritonitis. There were 45 instances, or 9 per cent., of this serious complication of the series. Many cases which had a pelvic peritonitis are excluded from this list, as our endeavor is to include only such as had a widespread peritonitis, the class usually designated in the histories as general peritonitis. Twenty-one, or 47 per cent., of these cases died, more than half the total fatalities. A number of them were further complicated. The importance of the time element in operative interference is here again forcibly illus-

trated. In the fatal cases the average time of illness before operation was nearly double that of the cases recovering, 4.7 as opposed to 2.5 days. Of the 12 cases with diffuse peritonitis not more than two days ill before operation, not one died. Of the fatal cases only 6 of the 21 lived longer than five days after operation, the majority succumbing before the end of the third day.

Acute suppurative cholecystitis was twice found at operation coincident with acute appendicitis. One of these cases in which a diffuse peritonitis was a further complication died. The other recovered.

The postoperative sequelae were as follows:

Sequelæ.	Incidence	Cases.	Mortality.
Fecal fistula	5.0	24	17
Pneumonia	2.5	12	33
Infected wounds in undrained cases	2.5	12	
<i>Secondary peritoneal abscess, including three</i>			
subphrenic	2.0	10	40
Pleurisy (one suppurative)	0.6	3	66
Phlebitis	0.4	2	50
Early ventral hernia	0.4	2	50
Facial erysipelas	0.4	2	50
Tonsillitis	0.4	2	
Rheumatism	0.4	2	
Alveolar abscess	0.4	2	
Pulmonary embolism	0.2	1	100
Septicæmia	0.2	1	100
Ileus paralytic (operated)	0.2	1	
Liver abscesses	0.2	1	100
Parotitis	0.2	1	
Bronchitis	0.2	1	
Pulmonary edema (slight)	0.2	1	
Abscess of neck	0.2	1	
Acute mania	0.2	1	

Here, again, it must be remembered that the mortality quoted does not necessarily represent that of the complication alone.

Fecal Fistula. Fecal fistula occurred 24 times in the series, an incidence of 5 per cent.; 4 died, a mortality of 17 per cent. Fistula alone is not in itself a serious menace to the life of a patient. All but one of the fecal fistula cases were drainage cases. In 22 cases in which we have compiled fuller data the following facts are of interest: In 14 cases the base of the appendix was ligated only, in 4 it was inverted, in 1 the caput coli was resected, and in 3 cases the appendix was not removed. The advantage of inversion of the stump over simple ligation, as regards the formation of fecal fistula may be only apparent, since data concerning the cecal wall is wanting. The outcome of these cases as fully as it could be obtained from the histories was:

Spontaneous closure of the fistula	12
Discharged with fistula still open (two patients left against advice)	4
Operative closure of fistula	2
Died, fistula still open (one case secondarily operated upon)	4

Of the 18 surviving cases, 12, or 66 per cent., closed spontaneously, and it is fair to assume that others of the 4 discharged, with fistulae draining, closed later without operation. Stillman, in reviewing the cases of appendicitis at the Roosevelt Hospital for the years 1910-1915, reports 64 per cent. of spontaneous cures of this condition. The incident of fecal fistula in this series is decidedly higher than in the Roosevelt Hospital series or the Presbyterian Hospital series reported by McWilliams. In this connection it is of interest to note that in our series, where the treatment of the stump is known, it was ligated in 245 cases and inverted in 196. Incidence of fistula is 5.7 per cent. in the ligated cases as opposed to 2 per cent. in the inverted.

Pneumonia. Pneumonia occurred 12 times, an incidence of 2.5 per cent. In 3 cases it was the only complication, and all of these survived. There were 4 fatalities in the series, or 33 per cent. It is fair to assume therefore that pneumonia will occur less frequently in those upon whom an early operation is performed, and there will consequently be less risk to the patient.

Secondary Abscess. Secondary peritoneal abscess occurred in 11 instances, being present in 1 case at operation and 10 times as a sequela. Three of these were subphrenic abscesses. Of the 11 cases, 4 died, a mortality of 36 per cent. Two of these deaths occurred in patients with subphrenic abscesses, a third in a patient who had septicemia, and a fourth in a patient with fecal fistula. In the Roosevelt Hospital cases this was the most frequent sequel, whereas in this series both fecal fistula and pneumonia occurred more often.

Ileus. This series is remarkable for the small number of cases of ileus, there being only 2. In 1 it was found at operation due to adhesions. A secondary operation was done on the second case, but the condition found was that of a paralytic ileus. Both cases recovered. In the Presbyterian Hospital series reported by McWilliams there were 18 cases of ileus out of a series of 687 cases of acute appendicitis, 14 paralytic and 4 mechanical obstructions, with 14 deaths; and in the Roosevelt series reported by Stillman there were 13 cases out of 965 operated upon for acute appendicitis, with 8 deaths.

It must be assumed, however, that some of our cases of diffuse peritonitis had a paralytic ileus, and therefore the above statistics may be misleading.

DIAGNOSIS AND PROGNOSIS. Some facts of interest from the stand-point of diagnosis and prognosis follow.

Previous Attacks. A history of previous attacks was obtained in one-fourth of the cases. Other writers have reported a great incidence of previous attacks, undoubtedly the more painstaking the historian the greater number of such previous facts in the history will be obtained.

Season of the Year. The question of seasonable variation was studied. The only deduction to be made is that season exercises no dominating effect.

Sex. The number of males in this series was a little more than twice that of females, while male deaths were relatively slightly less frequent; other writers agree to the preponderance of males in acute cases.

SYMPTOMS. Vomiting. Vomiting is a very constant symptom in acute appendicitis and is mentioned in the histories of four-fifths of the cases of this series. Five per cent. more had nausea without vomiting.

Constipation. When the condition of the bowels was recorded, constipation was five times as frequent as diarrhea.

Temperature. Acute appendicitis is characterized by moderate temperatures, although a normal temperature or high one does not preclude this diagnosis. Very high temperatures were followed by a higher mortality than the average; this is usually due, however, to an accompanying diffuse peritonitis, as may be seen from the following: there were 16 cases with a temperature over 104°, 10 of which had a diffuse peritonitis, the mortality being 25 per cent. The subsequent mortality in those cases with normal temperature at operation was approximately the average.

Temperature.	No. cases.	Subsequent deaths.	Mortality (per cent.).
Under 99°	33	2	6.2
99° to 100°	101	6	5.9
100° to 101°	130	3	2.3
101° to 102°	111	11	10.0
102° to 103°	68	4	5.9
103° to 104°	39	4	11.0
104° plus	16	4	25.0

Pulse. Pulse-rate seems to be of more significance than temperature from a prognostic stand-point, yet each individual case must be judged on its own merits. The accompanying figures summarize the facts:

Pulse at operation.	Percentage of cases.	Subsequent mortality.
Under 100	45	3.6
100 to 120	31	8.3
120 and over	23	11.0

Of the cases of diffuse peritonitis, four-fifths had a pulse of 100 or more at operation, and of the remaining one-fifth the majority were between 95 and 100.

Blood Count. A blood count was recorded in 377 of the cases. Neither a normal blood count nor a very high one rules out appendicitis, although such counts are comparatively rare. The mortality was higher among the two extremes and most favorable with a moderate leukocytoses. The relation of the numerical count to

the differential, as suggested by Gibson, did not appear to give any prognostic significance among our cases.

Blood count.	No. of cases.	Incidence (per cent.)	Mortality. (per cent.)
10,000 or under	22	6.0	14.0
11,000 to 15,000	119	31.0	6.0
16,000 to 20,000	113	30.0	5.0
21,000 to 25,000	69	18.0	9.0
26,000 to 30,000	28	7.0	11.0
31,000 plus	26	7.0	15.0

The average polynuclear count was 85 per cent.

With 80 per cent. or less polynuclears the mortality was 4 per cent.

With 80 to 89 per cent. polynuclears the mortality was 6 per cent.

With 90 plus per cent. polynuclears the mortality was 14 per cent.

The importance of early operation in regard to prognosis has been sufficiently dwelt upon under the discussion of mortality and diffuse peritonitis. It is important to add a table showing the duration of hospital stay with reference to time of operation. This emphasizes the fact that early operation is not only life-saving but time-saving.

Days ill at time of operation.	Average hospital stay.
One-half	13.1 days
One	10.7 "
Two	21.8 "
Three	21.7 "
Four and five	23.3 "
Six and more	25.2 "

Age. The relation of age to prognosis is important, as has already been brought out in discussing mortality; 87 per cent. of the cases in this series were between the ages of ten and fifty, with a mortality of 4.7 per cent., as opposed to a mortality of 23 per cent. in those at the two extremes. The accompanying table gives the figures:

Ages by decades.	No. of cases.	Deaths.	Mortality (per cent.).
1 to 9	42	7	16.0
10 to 19	158	2	1.2
20 to 29	174	12	6.9
30 to 39	62	3	4.8
40 to 49	36	3	8.3
50 plus	21	8	33.0

CONDITION OF THE APPENDIX. The cases were finely studied with a view of determining how much information of a prognostic nature could be derived from the condition of the appendix at operation. In 435 of the cases a division into three classes, suppurative, gangrenous without perforation, and perforative, was made. It is clearly recognized that these are different degrees of the same process, yet they represent the progress of the disease. Of course, the chief element in judging the outcome, when the surgeon looks into the abdomen, is the spread of the inflammation, yet it is thought that this tabulation may add something of interest:

Of the 117 perforated cases 17 died, a mortality of 15 per cent.

Of the 138 cases with gangrene and no perforation 9 died, a mortality of 6.5 per cent.

Of 180 suppurative cases without either perforation or gangrene 4 died, a mortality of 2 per cent.

Thirty per cent. of perforated, 16 per cent. of gangrenous and 10 per cent. of suppurative cases developed abscesses:

Twenty-four per cent. of perforated, 8 per cent. of gangrenous, and 1 per cent. of suppurative developed diffuse peritonitis.

The incidence of all complications in perforative cases is 61 per cent., in gangrenous 38 per cent., and in suppurative 22 per cent.

It appears from this that the danger of a diffuse peritonitis is greater when there is a perforation than when the inflammation spreads through the appendicular wall, for in the latter case there is a better chance of the peritoneum localizing the disease.

There were 20 cases, or 4 per cent., in whom it was not possible to remove the appendix. All but two of these were in abscess cases. Three of the 20 died, a mortality of 15 per cent.

SUMMARY. The mortality in our series of acute appendicitis cases was 6.8 per cent. We believe that this mortality figure may be greatly improved by making an early diagnosis followed by immediate operation, as we have shown that the mortality of those operated upon during the first day is less than 1 per cent., whereas by the third day it is over 10 per cent.

The mortality is higher in the young than in the old.

Death can be ascribed to intra-abdominal suppuration in 82 per cent. of our 34 fatal cases; of these 21, or 62 per cent., it was due to a diffuse peritonitis.

A temperature over 101° is usually indicative of diffuse peritonitis.

Abscess was found to be present in 21 per cent. while diffuse peritonitis was found in but 9 per cent., however, the mortality of the former was but 5.6 per cent. compared with 47 per cent. of the latter.

In the fatal cases of diffuse peritonitis the average time of the illness before operation was nearly double that of the cases recovering. Moreover, in 12 cases suffering from diffuse peritonitis and operated upon within forty-eight hours, there was no mortality.

Fecal fistula and postoperative pneumonia were the most common sequelae, the former in 5 per cent. the latter in 2.5 per cent.

We feel that it is impossible to make a diagnosis from the symptoms present, a severe case often showing the least marked signs.

In conclusion, we wish to emphasize the fact that operation should be performed as soon as the diagnosis of appendicitis is made, for the shorter the period between the onset of the disease and surgical interference the better the prognosis; the death rate being lower, few complications and sequelae developing, and the stay in the hospital shortened.

We wish to acknowledge our thanks to the surgeons of the first,

second, and third divisions of Bellevue Hospital for allowing us to use their records and to Dr. John A. Hartwell, director of the Cornell University Surgical Division, Bellevue Hospital, for his advice and help in writing this report.

BIBLIOGRAPHY.

- Burgess: *Brit. Med. Jour.*, February 24, 1912.
 Davis: *Boston Med. and Surg. Jour.*, 1915, cvxxii, 737.
 Denk: *Beitr. z. klin. Chir.*, 1913, lxxiv, 481.
 DeQuervain: *Cor.-Bl. f. Schweiz.-Ärzte*, 1913, xliii, 1609.
 Gibson: *Ann. Surg.*, 1906, p. 485.
 Haggard: *Southern Med. Jour.*, 1915, viii, 957.
 Kümmell: *Deutsch. med. Wchnschr.*, 1910, xxxvi, 1182, 1222, 1272.
 McWilliams: *Ann. Surg.*, 1910, li, 909.
 Moscheowitz: *Arch. f. klin. Chir.*, 1907, lxxxii, 683.
 Moscheowitz: *Ann. Surg.*, 1916, lxiii, 697.
 Schnitzler: *Deutsch. med. Wchnschr.*, 1909, xxxv, 2263.
 Stanton: *AM. JOUR. MED. SC.*, 1915, cxlix, 524.
 Stillman: *Med. and Surg. Reports, Roosevelt Hospital*, 1915, p. 70.
 Syme: *New York Med. Jour.*, 1914, xcix, 761.
 Zander: *Arch. f. klin. Chir.*, 1913, cii, 944.
 Zahradnický: *Cos. lék. Cesk.*, 1914, liii, 535.

TWO CASES OF CONGENITAL PERSISTENT ACROASPHYXIA
IN INFANTS.

By NOXON TOOMEY, M.D.,

INSTRUCTOR IN PEDIATRICS, STATE UNIVERSITY OF IOWA, VISITING PEDIATRIST TO
UNIVERSITY HOSPITAL, IOWA CITY, IOWA.

(From Department of Pediatrics and Contagious Diseases, State University
of Iowa.)

THE following seem to be two cases of acroasphyxia (acrocyano-sis), a local vasomotor disturbance usually symmetrical and confined to the extremities. Its pathogenesis is not known, but it is much like Raynaud's disease, of which it may be a form. It must be distinguished from acroparesthesia, erythromelalgia, multiple gangrene, scleroderma, acromegaly, and local cyanosis due to vasomotor paralysis (hemiplegia, etc.), pulmonary disease, or organic change in the arteries, such as stenosis of the aorta or thromb-angiitis obliterans. The disease was first described by Nothnagel in 1867, and since then about 35 cases have been reported. An hypertrophic form (edematous) and a hypesthetic form are usually recognized, but hypesthesia and hypertrophy may be absent. The disease occurs most frequently in girls and young women. My cases are the youngest reported. The disease has no hereditary basis, but several cases have been reported in hysterical individuals. The condition is said to be made worse by local chilling and possibly